RESIDUAL RIDGE RESORPTION : A REVIEW

Dr. AJAY GUPTA MDS, Professor & Head Department of Prosthodontics (D. J. College of Dental Sciences & Research, Modinagar - 201204 UP, India), Dr. BHAWANA TIWARI, Professor Department of Prosthodontics (D. J. Collge of Dental Sciences & Rresearch, Modinagar - 201204 U.P. India), Dr. HEMANT GOEL MDS, Reader Department of Prosthodontics, (D. J. Collge of Dental Sciences & Rresearch, Modinagar - 201204 U.P. India), Dr HIMANSHU SHEKHAWAT, Department of Prosthodontics ((D. J. Collge of Dental Sciences & Rresearch, Modinagar - 201204 U.P. India)

Introduction

Residual ridge is a term used to describe the shape of the clinical alveolar ridge after healing of bone and soft tissues following tooth extraction. Post tooth extraction, a cascade of inflammatory reactions is immediately activated, and the extraction socket is temporarily sealed by blood clotting. Epithelial tissues begin its proliferation and migration within the first week and the disrupted tissue integrity is quickly restored. Histologic evidence of active bone formation in the bottom of the socket is seen as early as 2 weeks after the extraction and the socket is progressively filled with newly formed bone in about 6 months. The most striking feature of the extraction wound healing is that even after the healing of wounds, the residual ridge alveolar bone undergoes a lifelong catabolic remodeling. The size of the residual ridge is reduced most rapidly in the first six months, but the bone resorption activity of the residual ridge continues throughout life at a slower rate, resulting in removal of a large amount of jaw structure. This unique phenomenon has been described as residual ridge reduction. The rate of RRR is different among persons and even at different times and sites in the same person. Residual ridge remodeling affects the function of removable prostheses, which rely greatly on the quantity and the architecture of jaw bones. Hence treatment of edentulous patients requires a maintenance phase that must be carried out throughout the life of a patient. Cost in economic and human term makes RRR a major oral disease.1

Consequences of RRR

There is apparent loss of sulcus width and depth. Muscle attachments are displaced closer to the crest of the residual ridge.Due to loss of VDO lower face height is reduced and mandible is rotated anteriorly. Patient may develop habitual prognathic appearance.Inter-alveolar ridge relationship is altered. Morphological changes in residual ridge may appear such as sharp, spiny, uneven residual ridges. Resorption of the mandibular canal wall and exposure of the mandibular nerve.Location of the mental foramina close to the top of the mandibular residual ridge.This provides serious problems to the clinician on how to provide adequate support, stability and retention of the denture.1

Pathology of RRR

Gross Pathology:A frequent lay expression for RRR is “My gums have shrunk”. Actually the basic change in RRR is a reduction in the size of the bony ridge under the mucoperiosteum. It is primarily a localized of bone structure. Sometimes it may leave the overlying mucoperiosteum excessive and redundant.There exists a wide variety of shapes and sizes of residual ridges. They are categorized into common residual ridge configuration in a system of six orders given by Atwood.2

Order I - Pre-extraction.
Order II- Post-extraction.
Order III- High, well rounded.
Order IV- Knife-edge.
Order V- low, well-rounded.
Order VI- depressed.

RRR does not stop with residual ridge, but may go well below where apices of teeth were, sometimes leaving only a thin cortical plate on the inferior border of the

mandible or virtually no maxillary alveolar process of the upper jaw.
In clinical examination usually one can visually judge the residual ridge form. However, sometimes a knife-edge ridge may be masked by redundant or inflamed soft tissues.

Microscopic Pathology: Microscopic studies have revealed osteoclastic activity on the external surface of the crest of residual ridges. The scalloped margins of Howship's lacunae sometimes contain visible osteoclasts which cause bone resorption. There exists a wide variation in the configuration, density and porosity of the residual ridges, sometimes even with evidence of osteoporosis. Studies have shown the presence of new bone and reversal lines inside the residual ridge and minute areas of bony repair on the periosteal side in some specimens.The mucoperiosteum shows varying degrees of keratinization, acanthosis, edema and architectural pattern of mucosal epithelium in the same mouth and between subjects.Similarly, varying degrees of inflammatory cells are found in areas that appear from clinically normal to frankly inflamed in edentulous patients or who were denture or non-denture wearers. Inflammatory cells include lymphocytes and plasma cells. There exists proximity of small blood vessels to area of bone resorption.2

Pathogenesis of RRR

Immediately following the extraction (order II), any sharp edges remaining are rounded off by external osteoclastic resorption, leaving a high well rounded residual ridge (order III). As resorption continues from the labial and lingual aspects, the crest of the ridge becomes increasingly narrow ultimately becoming knife-edged (order IV). As the process continues, the knife-edge becomes shorter and even eventually disappears, leaving a low well rounded or flat ridge (order V). Eventually, this too resorbs, leaving a depressed ridge (order VI).
RRR is chronic, progressive, irreversible and cumulative. Usually, RRR proceeds slowly over a long period of time, flowing from one stage imperceptibly to the next. Autonomous regrowth has not been reported. Annual increments of bone loss have a cumulative effect, leaving less and less residual ridge.3 Tallgren4 has presented an interesting graph of mean rates of RRR of patients who were studied at various post-extraction time periods over a 25 year period.In separate studies in different parts of the world, Tallgren, Atwood and Coy found that the mean ratio of anterior maxillary RRR to anterior mandibular RRR was 1:4.Therefore, it is true that, on the average, RRR is greater is greater in the mandible than in the maxilla, the reverse may be true in any given patient who comes for treatment. One must treat the particular patient, not the “average” patient.

Etiology of RRR:

RRR is a multi-factorial, biomechanical disease that results from a combination of anatomic, metabolic and mechanical determinants. Since all of these factors vary from one patient to the next, these different co-factors may combine in infinite variety of ways, thus explaining the variations in RRR between patients.1

Anatomic Factors:

RRRAnatomic factors
i.e. amount of bone and quality of bone.

Amount of bone: It is not a good prognostic factor for the rate of RRR, because it has been seen that some large ridges resorb rapidly and some knife edge ridges may remain with little changes for long periods of time. Although the broad ridge may have a greater potential for bone loss, the rate of vertical bone loss may actually be slower than that of a small ridge because there is more bone to be resorbed per unit of time and because the rate of resorption also depends on the density of bone.

Quality of bone: On theoretic grounds, the denser the bone, the slower the rate of resorption because there is more bone to be resorbed per unit of time.5
Metabolic factors:

RRRBone resorption factors
Bone formation factors

General body metabolism is the net sum of all the

building up (anabolism) and the tearing down (catabolism) going on in the body. In equilibrium the two antagonistic actions (of osteoblasts and osteoclasts) are in balance. In growth, although resorption is constantly taking place in the remodeling of bones as they grow, increased osteoblastic activity more than makes up for the bone destruction. Whereas in osteoporosis, osteoblasts are hypoactive, and, in the resorption related to hyperparathyroidism, increased osteoblastic activity is unable to keep up with the increased osteoclastic activity. The normal equilibrium may be upset and pathologic bone loss may occur if either bone resorption is increased or bone formation is decreased, or if both occur. Since bone metabolism is dependent on cell metabolism, anything that influences cell metabolism of osteoblasts and osteoclasts is important.

- The thyroid hormone affects the rate of metabolism of cells in general and hence the activity of both, the osteoblasts and osteoclasts.
- Parathyroid hormone influences the excretion of phosphorous in the kidney and also directly influences osteoclasts.
- The degree of absorption of Ca, P and proteins determines the amount of building blocks available for the growth and maintenance of bone.
- Vit C aids in bone matrix formation.
- Vit D acts through its influence on the rate of absorption of calcium in the intestines and on the citric acid content of bone.
- Various members of Vit B complex are necessary for bone cell metabolism.6

In general terms, anabolism exceeds catabolism during growth and convalescence, levels off during most of adult life and is exceeded by catabolism during disease and old age. Bone has its own specific metabolism and undergoes equivalent changes. At no time during life is bone static, but rather it is constantly rebuilding, resorbing and remodeling subject to functional and metabolic stresses.

Osteoporosis and residual ridge modeling

The clinical and pathophysicologic views of osteoporosis has been refined recently to the concept of Type I and II osteoporosis.

Type I osteoporosis is defined as the specific consequence of menopausal estrogen deprivation, and characteristically presents the bone mass loss, notably in the trabecular bone.

Type II osteoporosis reflects a composite of age related changed in intestinal, renal and hormonal function. Both cortical and trabecular bone are affected in Type II osteoporosis.

Functional Factors:

Functional factors include the frequency, intensity, duration and direction of forces applied to bone which are translated into cellular activity, resulting in either bone formation or bone resorption, depending upon on the patient's individual resistance to these forces.

When force within certain physiologic limits is applied to living bone ,that force, whether compressive, tensile of shearing, brings about by some unknown mechanism the remodeling of bone through a combination of bone resorption and bone formation. Masticatory and non-matiscatory force is ordinarily transmitted to the dento-alveolar bone through the periodontal ligament. Once the teeth are removed, the residual ridge is subjected to entirely different types of forces. Some postulate that RRR is an inevitable “disuse atrophy”. Others postulate that RRR is an “abuse” bone resorption due to excessive forces transmitted through dentures. Perhaps there is truth in both the hypotheses.1

Prosthetic Factors:

Ridge resorption may or may not occur in patients for whom dentures are not made. If resorption does occur, it is attributed either to disuse atrophy or as Lammie suggests, to an atrophying mucosa seeking a reduced area, thereby causing pressure resorption of the ridge. If resorption does not occur, this is attributed either to function by a patient who is able to “gum” food because of a small inter-ridge space or unknown factors. The prosthetic factors are extremely difficult to evaluate because of tremendous number of variables, including anatomic, metabolic and functional factors. The traditional design of dentures

includes many features whose goal is to reduce the amount of force to the ridge and to thereby reduce

RRR.7 These prosthetic factors include broad-area coverage (to reduce the force per unit area); decreased number of dental units, decreased buccolingual width of teeth, and improved tooth form (to decrease the amount of force required to penetrate a bolus of food); avoidance of inclined planes (to minimize dislodgement of dentures and shear forces); centralization of occlusal contacts (to increase stability of dentures and to maximize compressive forces); provision of adequate tongue room (to increase stability of denture in speech and mastication); adequate interocclusal distance during rest jaw relation (to decrease the frequency and duration of tooth contacts) etc.Various clinical studies have attempted to correlate one or more of these factors with the rate of RRR.8 Without exception, all of these studies have shown the same results, in regard to anyone factor, in a series of patients, some patients have RRR while others do not. Each group shows a wide range of RRR and an overlap with other groups.

TREATMENT AND PREVENTION OF RRR

The best way to manage the problem of residual ridge reorption is by using every means to prevent it.

Clinicians must try to retain residual roots whenever feasible.Overdentures help minimize ridge resorption and contribute to enhanced retention stability ,support of prosthesis along with preservation of proprrioception.

The introduction of dental implants has revoluitionized clinical practice.Use of implants for providing implant supported or implant assisted prosthesis also helps avert continuing residual ridge resorption.1

Impression technique

In patients with severely resorbed ridges, lack of ideal amount of supporting structures decreases support and the encroachment of the surrounding mobile tissues onto the denture border reduces both stability and retention.2 Thus the main aim of the impression procedure is to gain maximum area of coverage. For e.g., in mandibular ridge, obtaining a fairly long retromylohyoid flange helps to achieve a better border seal and retention.

• Selection of proper trays and the correct impression procedure is very essential for an accurate impression. Selective pressure technique is most widely advocated to manage RRR.It makes it possible to confine the forces acting on the denture to the stress bearing areas This helps in better withstanding the mechanical forces induced by denture wearing.

• Winkler describes a technique which uses tissue conditioners. An over extended primary impression of alginate is made. Occlusal wax rims are constructed and the borders are adjusted so that the lingual flange and sublingual crescent area are in harmony with the resting and acting phases of the floor of the mouth by an open and closed – mouth technique. 3 applications of conditioning material are used – each application approximately 3-10 minutes.9 The third and final wash is made with a light bodied material. This technique results in the impression that has tissue placing effect with relatively thick, buccal, lingual and sublingual crescent area borders. Miller used mouth-temperature waxes instead of tissue conditioners .

Correcting the occlusal vertical dimension:

Clinical studies have shown increased(excessive) OVD to be a common fault in many dentures.Guidelines suggest 2-5 mm of freeway space, but this may need to be increased in order patients or for those patients with atrophic mucosa verlying the residual ridges.

Reducing the forces required to drive the denture teeth through the bolus of food:

This may be achieved by either increasing the denture bearing area or reducing the size and altering the morphology of the occlusal table.

1) Increasing the denture bearing area:

Although prosthodontic norms recommend full use of the functional denture bearing area, this is rarely achieved. A consequence of this is that the smaller the size of the fitting surface of the denture, the greater are the loads applied to the underlying mucosa. In such cases, the denture bearing area may be increased using green stick impression compound before relining or by using a chairsid relining material prior to the denture being relined conventionally.1,2

2) Reducing the size and altering the morphology of the occlusal table:

Clinical experience indicates that many complete

lower dentures have posterior teeth set without consideration of possible support problems. In general, occlusal tables tend to be too large. This leads to problems of support and stability which singly and in combination, put too much pressure on the atrophic mucosa during function. The combination of reduced occlusal table and if necessary, increased denture bearing area can greatly reduce the load per unit area on the underlying mucosa and improve denture comfort, always assuming that the OVD is not excessive.10,1,2

- Eliminating disruptive occlusal contacts which lead to denture in stability:

Disruptive occlusal contacts may present in any border position and in 'normal' function as well as parafunction. Their detection and elimination must be carried out where changes in OVD and elimination of such disruptive forces are indicated, occlusal pivots can be of great benefit.

Summary and Conclusion

RRR is a multi-factorial, biomechanical disease that results from a combination of anatomic, metabolic and mechanical determinants. Since all of these factors vary from one patient to the next, these different co-factors may combine in infinite variety of ways, thus explaining the variations in RRR between patients.

RRR is chronic, progressive, irreversible and cumulative.

It is important to incorporate measures so as to minimize resorption of residual ridges in our treatment plan.

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